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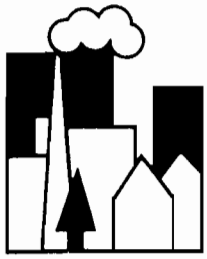

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An empirical study of equity in the finance and delivery of health care in Britain

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Owen O'Donnell
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DISCUSSION PAPER 85

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Abstract

This paper presents evidence on the extent to which the finance and the delivery of health care in Britain are equitable. The analysis of health care delivery focuses on whether there is 'equal treatment for equal need' irrespective of income. Examination of data from the 1985 General Household Survey reveals substantial inequalities in the distribution of (self-reported) morbidity. The bottom income group accounts for 30% of all individuals with a long-term illness but only 20% of the sample. There is less inequality in the distribution of health care. Consequently, the proportion of total health care resources consumed by the higher income groups is greater than the proportion of total morbidity they report. However, this simple comparison of the distribution of resources with the distribution of morbidity is not appropriate for assessing whether there is 'equal treatment for equal need'. After appropriate standardisation for differences across income groups in age, gender and the incidence of morbidity, there is little evidence of inequality in the distribution of health care in Britain. The distribution of standardised NHS expenditure shows a slight pro-poor bias; adding private health care consumption produces (for adults only) a slight pro-rich bias. Neither of these inequalities are significant.

These results differ from previous research which claimed to show substantial inequities in the delivery of NHS care in favour of the middle classes.

On the finance side, we examine whether the finance of health care in Britain is progressive. Since health care in the UK is primarily financed from taxation, the analysis essentially amounts to an assessment of the progressivity of general taxation.

The analysis, based on figures published by the Central Statistical Office, shows that in 1985 taxes were raised broadly in proportion to incomes. Whilst income taxes were progressive and National Insurance contributions neutral, indirect taxes were regressive.

The omission from the analysis of user charges for NHS services is unlikely to be important since these account for only 3% of NHS finance. Private health care payments, which are also omitted, are likely to be progressive because it is predominantly the higher income groups who purchase private care.

Our conclusions are that the British health care system appears close to allocating health care resources on the basis of 'equal treatment for equal need' and extracting payments in proportion to incomes.

INTRODUCTION

It is a widely accepted proposition that one of the aims of the National Health Service has been to achieve equity in the delivery of health care. However, how equity should be defined and whether, however defined, it has been achieved, remain the subjects of considerable controversy. In this paper we examine two aspects of equity in the National Health Service (NHS). The first is horizontal equity in the delivery of care, the second is vertical equity in the finance of care. In making the separation between delivery and finance we explicitly recognised that the equity goals for the health service tend to be defined in terms of delivery of care, while the tax financed nature of the NHS means that the goals on the finance side are those that are used for systems of taxation.

The separation of delivery from finance allows comparison between our results with previous analyses of the delivery side. The evidence to date on the delivery side is mixed. Research using data from the 1970s, for example,Le Grand (1978), appeared to show substantial horizontal inequity in favour of the middle clases. Analysis using data on subsets of NHS expenditure (Collins and Klein 1980) or on data from the mid 1980s (O'Donnell and Propper, forthcoming) could find no evidence of inequity in delivery.

The explicit separation of finance and delivery and the particular methodological approach adopted in this paper follow proposals made by Wagstaff et al (forthcoming and 1990). On the delivery side our focus is on departures from horizontal equity, where equity is defined with respect to income. We undertake two sets of analysis. In the first we examine the unstandardised distribution of health care across income groups and compare

this to the distribution of morbidity. In the second, we undertake regression analysis to standardise the distribution of health care for differences in age, sex and morbidity across income group and examine the resulting distribution of standardised health care expenditure. For both analyses we present summary measures of the extent of inequity, proposed for use in health care by Wagstaff et al (forthcoming) and based on departures from proportionality.

On the finance side, our focus is on vertical inequity with respect to income. As health care in the UK is primarily financed from general taxation, our analysis essentially amounts to an assessment of the progressivity of general taxation. We calculate measures of progressivity used in the analysis of taxation (Kakwani 1977, Suits 1977).

The paper is organised as follows. In Section 1 the system of health care finance and delivery in the UK is briefly described and the concept of equity embodied in policy statements concerning health care are discussed. In Section 2 we turn to an examination of equity in the delivery of health care. Using data from the 1985 General Household Survey, we examine the distribution of unstandardised morbidity and health care expenditure and the distribution of standardised health care expenditure across income groups. Summary measures of departures from equity are presented. Using additional survey material we discuss the extent to which the results we obtain may be indicative of unequal treatment for equal need. In section 3 we examine the finance side. Using published data we present evidence on the progressivity of the finance of health care in the UK. Our conclusions are given in Section 4.

1 THE UK HEALTH CARE SYSTEM

The UK spends approximately 6.7% (1985) of its GNP on health care (OHE, 1987). Health care is predominantly financed and provided through the public sector. The majority of health care is supplied by the public National Health Service (NHS). Public expenditure accounted for 95.2% of total expenditure on health care in 1985 (op cit) and the bulk of these funds (97%) is raised through general taxation. There are no hypothecated taxes for the NHS. The remainder of NHS funding is raised through user charges.

The NHS comprises Hospital and Community Health Services and Family Practitioner Services (general practitioners, dentists, pharmacists and opticians). Doctors in the hospital sector are salaried employees. In the primary care sector general practitioners contract with the health service to provide care for a defined population and derive their income from a mixture of salary, capitation payments and some fee-for-service payments. The recent reforms of the NHS, initiated in the White Paper 'Working for Patients' (Cmd 555), seek to divorce the purchasers of health care (District Health Authorities and GP budget holders) from the providers (public and private hospitals and community services) (Culyer et al 1990). The aim is to introduce greater competition in the delivery of health care, whilst maintaining a tax financed service. It is too early to assess the impact of these reforms, but, in principle, they offer greater opportunities for the private sector in the delivery of health care in the UK.

At present a limited private sector exists. In terms of total size this sector is dwarfed by the NHS, total expenditure on the former being approximately £1 bn and on the latter £17b in 1985 (OHE, 1987). However, the specialisation of the private sector in the provision of acute surgica'

treatment means that its contribution to this type of care is quite large, especially in more affluent regions (Nicholl et al, 1989). Approximately 9% of the population are covered by private health insurance (Laing, 1987). The White Paper reforms introduce tax relief on private health insurance premiums for people over the age of 60, which is expected to increase, though not dramatically, the number covered by private insurance (Propper and Maynard 1990).

Despite any incentives provided in the 1989 White Paper to increase private finance and/or delivery of care, the principles on which the NHS was established reflect an egalitarian concept of equity. The White Paper introducing the NHS stated.

"The Government .... want to ensure that in future every man, woman and child can rely on getting .... the best medical and other facilities available; that their getting them shall not depend on whether they can pay for them or any other factor irrelevant to real need." (Cmd. 6502)

This commitment to the allocation of health care on the basis of need, rather than ability to pay, was reiterated in the 1989 White Paper. It is therefore appropriate to examine whether the distribution of health care in Britain is consistent with the policy objective 'equal treatment for equal need'. It is to this exercise that we now turn.

2 EQUITY IN THE DELIVERY OF HEALTH CARE

2.1 Methodology and Data

Following Wagstaff et al (forthcoming), we use two methodologies to examine the distribution of health care in relation to need across income groups. The first involves ranking individuals by income and comparing the cumulative proportion of health care expenditure with the cumulative proportion of morbidity in each income group. This is called by these authors the 'relative concentration curve' approach. The degree of inequity is summarised by an index, HI_{LG}, which is defined as the difference between the concentration curve for expenditure and that for morbidity, ie.

$$HI_{LG} = CI_{exp} - CI_{ill}$$

where CI_{exp} and CI_{ill} are the concentration indices for health care expenditure and morbidity respectively. (Each concentration index is calculated in the same way as a gini coefficient; it is the area between the concentration curve and the diagonal divided by the total area between the diagonal and the x and y axes.)

This index is positive if there is pro-rich inequity (if the proportion of health care consumed by the higher income groups is greater than their proportion of total morbidity) and negative if there is pro-poor inequity. The second procedure uses regression analysis to standardise the health care consumption of each income group for differences in the group's age, sex and morbidity composition from the sample average. The resulting standardised expenditures will be equal across income groups if there is equal treatment

for equal need. Again the degree of inequity is summarised by an index, HI_{VWP}. This index measures departures from proportionality and is positive (negative) if there is pro-rich (pro-poor) inequity.

The data employed in our analysis of the delivery of health care are taken from the 1985 General Household Survey (GHS). This is a national large scale survey of over 10,000 households and 25,000 individuals which includes microdata on individuals' health care utilisation, self reported morbidity and income. The survey was used in earlier research in this field (Le Grand 1978, Collins and Klein 1980, Hurst 1985) and has been widely used in analysis of social and economic policy.

The income measure used in the analysis is gross family income, adjusted for the size and structure of the family (i.e. equivalent income). Equivalent family, rather than individual or household, income is used, since it is believed this makes the most plausible assumption about the degree of income pooling which generally occurs within households.[1] The equivalence scale used is that derived by McClements (1978), which is currently used by the Department of Social Security[2].

The 1985 GHS provides information on the utilisation of general practitioner, out-patient, accident and emergency and in-patient care. No information on individuals' length of stay as in-patients is provided. In the analysis it is therefore assumed that average length of stay is constant across all income groups. To the extent that there are systematic variations in length of stay across income groups, the distribution of health care calculated from the GHS data will mask these differences.[3]

The GHS does not survey the institutionalised population. A major omission from our analysis is therefore the distribution of institutional care. Individuals resident in long stay institutions are likely to be both amongst the poorest members of society and amongst the most intensive users of health care. Their omission will therefore reduce the relative use of health care recorded for the poor. But the health status of the institutionalised population is generally very low and so it is not possible to predict the impact of their omission on the distribution of health care relative to morbidity.

To identify aggregate use of health care by each individual it is necessary to weight the various types of health care recorded in the GHS. The services used by each individual were multiplied by their unit costs to derive the total health care expenditure on each individual[4]. Both NHS and private care have been costed using the unit costs of the former. There was a pragmatic reason for this; there are no reliable data on the costs of private hospitals. However, there is also a theoretical justification for using the same costs for both sectors. The aim of this study is to examine the distribution of the benefits from health care. If differences in costs between sectors reflect merely differences in 'hotel' services, rather than quality differences which have implications for the health of patients, then the estimated distribution of health care should not reflect such variations in cost. In the UK, the private sector concentrates on the provision of elective surgery. Treatment is usually provided by the same doctors who carry out such operations on NHS patients and often in NHS hospitals. In these circumstances, little or no differences are expected in the quality of NHS and private care and so the use of the same costs for care in the two sectors would seem justified.

The use of the same NHS costs for all income groups embodies the assumption of no systematic variation in the quality of NHS care across incomes. There is some evidence that this is an incorrect assumption, at least with respect to GP consultations. Two rather dated studies found GP consultations were generally longer for the middle classes (Buchan and Richardson, 1973, Cartwright et al 1974). It does not necessarily follow that a longer consultation is of greater quality, but further evidence from the Cartwright et al study revealed a greater degree of doctor-patient communication in consultations by middle class individuals. Metcalfe et al (1983) found consultations by the middle classes were more likely to result in referrals to hospital or diagnostic tests, whereas lower class patients were more likely to receive a prescription or National Insurance certificate. Unfortunately, given the available data, any variations in quality of care across income groups cannot be incorporated in the present analysis.[5]

The morbidity questions asked in the GHS are designed to distinguish between health state and health status. Measures of health state identify temporary interuptions to an individual's normal level of health, whereas health status measures identify long term deviations from perfect health (Blaxter, 1990). As a measure of health state, individuals are asked whether they have experienced an illness or injury which has restricted their usual activity in the preceding two week period. This variable was not used in our analysis. Instead we concentrated on measures of health status. Respondents are asked whether they have any long standing illness, disability or infirmity. Those responding positively are asked whether they experience limited functioning due to this illness. Three measures, any chronic (ANYCHRON), non-limiting chronic (CHRONIC) and limiting chronic (LTDCHRON),

were constructed from responses to these questions. The first was positive if the respondent answered 'yes' to the first question, the second was positive if they answered 'yes' to the first question but 'no' to the second, and the third was positive if they answered 'yes' to both. (As the measures are non-exclusive they were not all used together in any of our analyses).

The above indicators of health status derive from a functional model of health. A subjective model requires different measures (Blaxter, 1990). In the GHS adult respondents are asked to rate their general health as: 'good', 'fairly good' or 'not good'. This subjective indicator of morbidity was used in the present analysis, the variable not good health (HEALTH) taking value 1 if the respondent recorded her health as 'not-good'.

The GHS provides data on the morbidity (with the exception of the 'not-good' health variable) and health care utilisation of all household members, whether adult or children. For the purposes of comparability with data from other European countries we define two samples in our data - a full sample containing data on adults and children and an adult-only sample. All analyses are undertaken for both samples, those for the adult-only sample being presented first.

2.2 Unstandardised Distribution of Morbidity and Health Care

Table 1 presents the number of individuals in each income quintile who report each type of morbidity as a percentage of all individuals reporting that type of morbidity. Comparison of these figures with the 20% of the total population in each income group indicates a negative association between income and self reported morbidity for all measures of morbidity in both the

adult-only and the full sample. This is confirmed by the negative sign on each concentration index. Chi-squared tests indicate this association is statistically significant at the 0.001 level for each separate morbidity category. However, while all of the self-reported morbidity indicators show the poor are less healthy than rich, there is some variation in the degree of inequality across morbidity measure. The measure of self-assessed health (available for adults only) shows most inequality. Limiting long standing illness is more unequally distributed than non-limiting illness. This pattern appears in both the adult-only and the full sample. The absolute magnitude of the concentration indices are consistently slightly larger for the adult only sample than for the full sample indicating that health inequalities are slightly less pronounced among children.[6]

The table also indicates that the distribution of unstandardised expenditure - both NHS and total (public and private) - is pro poor, but NHS expenditure is more pro-poor. Given the positive association in the UK between private insurance coverage and income (see Section 3) and hence between income and private sector utilisation, this difference in the distributions of NHS and total expenditure is in the expected direction.

Both morbidity and unstandardised expenditure are thus pro-poor. However, the positive HI_{LG} indices (calculated as C_exp-C_ill) signify that the net distribution of unstandardised expenditure and morbidity is pro-rich. That is, the degree of pro-poor inequality in the distribution of morbidity is greater than the pro-poor inequality in the distribution of health care. This is the case for both NHS and total health care expenditure, for all measures of self-assessed morbidity and for both the adult-only and the full sample. As expected from the distribution of expenditure, total expenditure

relative to morbidity shows more pro-rich bias than NHS expenditure. The indices show the most pro-rich bias is in the distribution of expenditure relative to self-assessed health status, and the least bias in expenditure relative to non-limiting long standing illness. The distribution across adults appears to be slightly more unequal than for the full sample. However, it should be noted that standard errors have not been calculated for the indices,[7] and so it cannot be established whether these differences are statistically significant.

For both samples, the concentration curve for non-limiting long standing illness crosses that for NHS expenditure. The calculation of the HI_{LG} index in this situation embodies the judgement that inequity which is to the disadvantage of the lower income groups can be offset by inequity suffered by the higher income groups. As Wagstaff et al (forthcoming) point out, if the objective were not to determine whether there is overall a bias in favour of the poor or the rich in the distribution of health care, but to measure the total amount of inequity, regardless of where it occurs in the income distribution, then the HI_{LG} index would not be appropriate as an indicator of inequity.

Table 1 DISTRIBUTION OF UNSTANDARDISED EXPENDITURE AND MORBIDITY

(a) Adults only: N=13204

Income Quintile	% of NHS exp.	% of total exp.	% of all with non-limiting longstanding illness	% of all with limiting longstanding illness	% of all with any longstanding illness	% of a with n good health
Bottom	25.32	24.17	27.32	32.88	30.10	37.01
2nd	24.69	23.66	24.69	27.67	26.18	29.23
3rd	18.57	18.27	18.15	16.42	17.29	15.43
4th	17.25	17.48	14.86	12.34	13.60	11.03
Top	14.17	16.43	14.97	10.68	12.83	7.29
Concentration Indices	-0.121	-0.088	-0.140	-0.243	-0.191	-0.31
C_nhsexp - C_ill			0.019*	0.122	0.070	0.19
C_exp - C_ill			0.052	0.155	0.103	0.22

(b) Adults and children: N=17729

Income Quintile	% of NHS exp.	% of total exp.	% of all with non-limiting longstanding illness	% of all with limiting longstanding illness	% of all with any longstanding illness
Bottom	25.15	24.24	26.49	31.74	29.12
2nd	23.36	22.55	24.31	26.90	25.61
3rd	18.53	18.21	17.74	16.22	19.98
4th	17.83	17.96	15.15	12.98	14.07
Top	15.13	17.05	16.31	12.15	14.23
Concentration Indices	-0.106	-0.078	-0.119	-0.215	-0.167
C_nhsexp - C_ill			0.013*	0.109	0.061
C_exp - C_ill			0.041	0.137	0.089

* Note: concentration curves cross.

The comparison of concentration indices for unstandardised morbidity and expenditure is essentially the same procedure as that adopted by Le Grand (1978). It has been shown (Wagstaff et al, forthcoming; O'Donnell and Propper, forthcoming) that this methodology will indicate pro-rich inequity in the distribution of health care relative to morbidity, even if there is equal treatment within each morbidity group, if the rich experience less morbidity than the poor. Thus the above results may reflect this bias. In the next section we adopt another methodology which does not impart this bias.

2.3 Standardised Distribution of Health Care

The methodology used is that proposed by Wagstaff et al (forthcoming). Essentially, rather than compare the distribution of various morbidity measures with the distribution of expenditure, expenditure is standardised for differences in morbidity and then the distribution of this variable across income groups is examined. Standardisation by regression analysis is equivalent, in some cases, to the direct standardisation as employed by epidemiologists in, say, the construction of standardised mortality ratios. As health care is distributed such that a large proportion of any sample will have zero recorded expenditure in any year, standardised expenditure is calculated as the product of expected mean standardised expenditure conditional on expenditure being positive, and the standardised probability of expenditure being positive. In undertaking standardisation, we sought to control for differences in age and sex as well as morbidity. For each of the 5 quintile groups, two equations are estimated. In the first the relationship between the control variables and the probability of expenditure being positive is estimated. The second estimates the relationship of the variables

with expenditure, given it is positive. Specifically, the equations take the following form:

$$pr(m_i>o) = F(a_k + b_k g_i + \sum_{l=2}^{3} c_{kl} h_{li} + \sum_{j=2}^{5} d_{kj} x_{ji} + e_k s_i) \qquad (1)$$

$i \in$ income group k

and

$$m_i | m_i>0 = a_k + b_k g_i + \sum_{l=2}^{3} c_{kl} h_{li} + \sum_{j=2}^{5} d_{kj} x_{ji} + e_k s_i + u_{ki} \qquad (2)$$

where m_i = expenditure for person i

$pr(m_i > 0)$ = the probability that expenditure is positive

$m_i | m_i > 0$ = expenditure given expenditure is positive

F = standard normal cumulative distribution

g_i = 1 if individual is female

x_{2i} = 1 if individual is aged 18-34

x_{3i} = 1 if individual is aged 35-44

x_{4i} = 1 if individual is aged 45-64

x_{5i} = 1 if individual is aged 65+

h_{2i} = 1 if individual reports non-limiting chronic illness

h_{3i} = 1 if individual reports limiting chronic illness

s_i = 1 if individual reports her health as poor and 0 otherwise.

Final standardised expenditure is the product of standardised expenditure conditional on it being positive and the standardised probability of expenditure being positive. Thus standardised mean expenditure for each quintile group was calculated as:

$$m_k^* = \hat{m}_k . \hat{pr}(m_k>0) \qquad (3)$$

where

$$\hat{m}_k = \hat{a}_k + \hat{b}_k\tilde{g} + \sum_{l=2}^{3} \hat{c}_{kl}\tilde{h}_l + \sum_{j=2}^{5} \hat{d}_{kj}\tilde{x}_j + \hat{e}_k\tilde{s}$$

$$\hat{pr}(m_k>0) = F(\hat{a}_k + \hat{b}_k\bar{g} + \sum_{l=2}^{3} \hat{c}_{kl}\bar{h}_l + \sum_{j=2}^{5} \hat{d}_{kj}\bar{x}_j + \hat{e}_k\bar{s})$$

m_{k+} = standardised expenditure, income group k, $\hat{m}_k$ = standardised positive expenditure, $\hat{pr}$ $(m_k > 0)$ = standardised probability expenditure is positive, $\tilde{g}$, $\bar{g}$, $\tilde{h}_1$, $\bar{h}_1$, 1 = 2, 3, $\tilde{s}$, $\bar{s}$ and $\tilde{x}_j$, $\bar{x}_j$, j = 2, ..., 5 are conditional sample means for the gender, morbidity and age variables respectively.

Various sets of morbidity measures were used in the standardisation procedure. For each set a corresponding equation (1) and (2) was estimated. All versions of equations (1) and (2) contained age and gender dummies (estimation for the adult only subsample requiring one less age dummy).

While the standardisation procedure is not an explanatory model of health care consumption, it is important to test the distributional assumptions in equations (1) and (2). Erroneous distributional assumptions may result in biased parameter estimates and so inaccurate predictions of standardised expenditure. Carrying out the standardising procedure by estimating equations (1) and (2) implicitly assumes independence of the event that expenditure is positive and the level of (positive) expenditure. This assumption was tested against the alternative of non-independence, using a Heckman approach to estimate the correlation between the error terms in the 2 equations. The specification of equations (1) and (2) as a two-part model (with or without independence) was also tested against the alternative hypothesis of a tobit model.

These tests were undertaken for both the full and the adult-only sample

and for all 5 income quintiles. Details of the tests are given in the Appendix and the results are presented in Tables A1 and A2 of the Appendix. The test results indicate that the tobit specification can be rejected in all cases. The assumption of independence between the censored OLS (equation (1)) and the probit equation (equation (2)) could be rejected in only two cases (adult sample, income groups 1 and 4) and even in these cases, the estimates of the correlation between the disturbances of the 2 equations was insignificantly different from zero. We thus conclude there is independence between equations (1) and (2).

The result may reflect the nature of health care consumption. The decision to consult a doctor is made by the individual. Once the individual has initiated care, the level of care she receives is largely determined by the doctor. A degree of independence between the probability of consulting and the level of health care received by those who do consult may therefore be expected. Given that we have not estimated an explanatory model, we do not claim confirmation of such a hypothesis from our results but offer it as a possible rationalisation of the results.

On the basis of these test results, the two part model of equations (1) and (2) was adopted for the standardisation procedure. However, in probit models non-normality, heteroskedasticity or omitted variables may result in inconsistent parameter estimates (Godfrey 1988). Tests of normality and a general test for misspecification of equation (1) were therefore undertaken. All but one of the models showed no evidence of non-normality. The Orme (1988) tests presented at the bottom of Tables A1 and A2 indicate some misspecification (for example, perhaps omission of variables) may be present for income quintiles 1-4 (adult-only) and quintiles 2-4 for the full sample.

As the form of equations (1) and (2) was chosen for the purposes of standardisation and not as an explanatory model, it is not surprising that there may be some misspecification. Examination of the test results indicate there may be significant interaction effects between gender and morbidity and gender and age that are omitted from equation (1). Thus we should note that the parameter estimates used in the standardisation procedure may be biased for quintiles 1-4, but the extent or effect of the bias has not been established and may be small. Indeed, it is worth noting that for this data the direct standardisation method gave very similar results to the regression standardisation method.

The distribution of standardised health care for the adult-only sample is given in Table 2a. Standardisation was undertaken using several sets of morbidity measures; the variables used in each standardisation are indicated at the top of the relevant column of the table. The morbidity variables in column (4) is our preferred set of standardising measures; the other sets are included for purposes of comparability with the results from other countries.

It is clear that all the standardised data display a more pro-poor distribution than the non-standardised, in other words, HI_{VWP} is more pro-poor than HI_{LG}. This result is in accord with the theoretical discussion in Wagstaff et al (forthcoming).

Table 2 DISTRIBUTION OF STANDARDISED EXPENDITURE

a) Adults N=13204

	Standardising Variables							
	(1) Age, sex, anychron		(2) Age, sex, health,		(3) Age, sex, anychron, health		(4) Age, sex, ltdchro chronic, health	
Income Quintile	% of NHS	% of Total	% of NHS	% of Total	% of NHS	% of Total	% of NHS	% of Total
Bottom	23.44	22.05	21.35	19.99	20.94	19.56	20.74	19.35
2nd	23.91	22.57	22.50	21.13	22.40	20.98	22.26	20.82
3rd	19.09	18.47	19.21	18.46	19.24	18.45	19.34	18.51
4th	18.23	19.03	18.95	19.62	19.34	20.03	19.45	20.16
Top	15.33	17.88	17.98	20.80	18.08	20.98	18.21	21.16
Conc. Indices	-0.089	-0.048	-0.041	0.002*	-0.035	0.009*	-0.031	0.013*

* Concentration curves cross 45-degree line

b) Adults and children N=17729

	Standardising Variables			
	(1) age, sex, anychronic		(2) age, sex, ltdchron, chronic	
Income Quintile	% of NHS	% of Tot	% of NHS	% of Tot
Bottom	23.63	22.58	23.00	21.94
2nd	22.59	21.59	22.19	21.17
3rd	19.17	18.65	19.36	18.80
4th	18.62	18.95	18.93	19.26
Top	15.99	18.22	16.52	18.83
Concentration Indices	-0.080	-0.047	-0.067	-0.033

Looking first at NHS expenditure, the negative value of the concentration indices signify that this expenditure is weakly pro-poor.[8] Moving across the columns it is clear the effect of adding more, and more finely categorised, morbidity measures is to reduce the absolute size of the concentration index. This indicates that using more detailed measures of ill-health reduces the apparently pro-poor bias in the distribution of NHS expenditure. The picture is a little different for total (public and private) standardised expenditure. If any chronic illness is used as the morbidity indicator, the distribution is pro-poor, but less pro-poor than NHS expenditure as the absolute size of the index is almost 50% lower than that for NHS expenditure. For all the other morbidity measures, the standardised distributions of total expenditure indicate little evidence of either pro-poor or pro-rich bias. All of the indices are positive, but small in magnitude. In general, the top and second bottom quintiles get more than their fair share of expenditure at the expense, in the main, of the middle quintile. All three concentration curves cross the 45-degree line. Calculating the HI_{WP} index in this situation embodies the judgement that inequity favouring a lower quintile (in this case the second bottom) can be offset by inequity favouring a higher quintile (in this case the top) (Wagstaff et al, forthcoming). This assumption is adopted since our intention is to determine whether there is net inequity in favour of the rich or poor rather than to measure the gross level of inequity in the health care system. (Wagstaff et al, op cit).

The results for the full sample are presented in Table 2b. The indices show a weakly pro-poor distribution for all the morbidity measures. Comparision of the indices across different morbidity measures indicates a similar pattern to the adult-only sub-sample: disaggregation of morbidity

reduces the extent of measured pro-poor inequity. Total standardised expenditure is again less pro-poor than NHS standardised expenditure, the absolute values of the concentration indices being almost 50% less for total expenditure than for NHS expenditure. It appears that although small in aggregate, the use of the private sector seems to have a substantial effect on the distribution of health care in Britain.

The lack of a self-assessed health variable for children means that direct comparison of the standardised results across the two samples can only be made for the case of standardisation by the 'any chronic illness' indicator of morbidity. For this measure the distribution of standardised expenditures in the two samples are very similar. The concentration indices for total expenditure for the adult-only and the full sample are -0.048 and -0.047 respectively. For NHS expenditure, the respective figures are -0.089 and -0.080 respectively.

In the absence of standard errors we cannot say whether the concentration indices presented in Tables 2a and 2b indicate that the distributions are significantly different from an equal distribution. Nor can summary measures indicate the possible sources of income related inequality. Examination of the estimated probit and OLS equations (equations (1) and (2)) from which the standardised results were derived can provide some guide to the significance and source of any income related inequality. The sign and magnitude of each of the variables used in the standardisation can be examined. In particular, it is possible to test whether income has any significant effect on the levels of standardised expenditure. Details of these tests are given in the Appendix.[9]

The tests using data for the full sample indicate that there are no significant differences across the quintiles in the level of total (public and private) health care expenditure. Neither the direct effect of income nor the indirect effect (through its interaction with morbidity measures, gender or age) appears to differ significantly across the 5 quintiles. We can thus perhaps conclude that the weakly pro-poor distribution indicated by the concentration indices in table 2b does not appear to be significantly different from an equal distribution.

For the adult-only sample, income appears to affect levels of expenditure in two opposing directions. The 'autonomous' level of expenditure - that which is unrelated to any of the standardising variables - is not the same in each quintile. In fact, this level is lower the higher the income group and tests (weakly) reject the hypothesis that these differences are due to chance variation. The level of treatment which is related to the standardising variables also differs significantly across income quintiles. However, the difference across income groups is in the opposite direction; there is positive interaction between both age and morbidity and income; the lower income groups get less expenditure for a given level of age and morbidity. The total effect of income on standardised expenditure is significantly different from zero. This result may seem surprising given that the figures in the final column of table 2a show no clear bias in favour of the rich or poor. The explanation lies in the fact that the direct and indirect effects of income on health care consumption work in opposite directions, consequently the net effect of income is small.

2.4 Discussion

There is little evidence of systematic bias in favour of either the rich or poor in the distribution of total health care expenditure in Britain, but the results show some evidence of a slightly pro-poor distribution of NHS care, standardising for differences in age, sex and self-reported morbidity. One interpretation of these findings is that the rich substitute private for NHS care and consequently make less of a claim on NHS resources for a given level of need. Another (not mutually exclusive) interpretation is that, for a given level of self-reported morbidity, individuals in the lower income groups are, on average, in greater need of health care. If this is the case, then the slightly unequal distribution of NHS resources is not necessarily indicative of unequal treatment for equal need.

Approximately 30% of the GHS sample reported long-standing illness in 1985. Substantial variation in the conditions suffered by these individuals would be expected. Unfortunately, data are not available in the 1985 GHS to determine whether there is systematic variation across income groups in the type and severity of conditions suffered. However, some light can be shed on this issue through examination of another large scale data set.

The Health and Lifestyle Survey (HLS) (Cox et al, 1987) carried out in 1984-85, is based on a large sample (n = 9000) of the adult population and includes information on income and self-reported morbidity, as well as physiological and psychological measures of health status. The measure of income used in this survey is not as detailed as that in the GHS. Respondents are only asked to identify the range within which their current net household income lies. However, the survey provides detail on medical conditions. As

a follow-up to the question of whether an individual has a long-standing illness, they are asked to identify the condition(s) from which they suffer (eg, arthritis, diabetes, heart disease, back trouble).

A chi-square test revealed that the lower income groups were significantly more likely to suffer from more than one condition ($p << 0.001$) (where p = probability). Much of the significance of this relationship disappeared once allowance was made for the different age/sex compositions of the income groups. The sample was broken up into six age/sex groups. In each of these, a higher proportion of individuals from the lower income categories reported more than one condition but the relationship only remained significant in one of these groups ($p = 0.05$; in one other group the relationship was significant at the 10% level).

The lower income groups were significantly more likely to report long standing illness as a result of arthritis/rheumatism ($p << 0.001$), heart disease, angina, heart attack ($p << 0.001$), stroke, arterial disease ($p << 0.001$), bronchitis, emphysema ($p = 0.001$) and anaemia, blood disorder ($p = 0.015$). The higher income groups were more likely to report long standing illness as a result of back trouble ($p = 0.003$), hay fever/allergic conditions ($p < 0.001$), skin disease, eczema, dermatitis ($p = 0.035$), migraine, chronic headache ($p = 0.014$). This evidence suggests that among individuals reporting long standing illness those from the lower income groups are likely to suffer more serious conditions. After splitting the sample up into two age groups, the direction of most these relationships remained the same but their significance was greatly reduced. The lower income groups were still significantly ($p=0.05$) more likely to suffer from arthritis/rheumatism, heart disease, etc, and anaemia/blood disorder in one of the two age groups. For

the other age group, significance was only at the 10% level. In the cases of stroke/arterial disease and bronchitis/emphysema, the relationships were not significant for one of the age groups and significance was only at the 10% level for the other. Individuals in the higher income groups remained significantly ($p = 0.05$) more likely to report back trouble, hay fever/allergies and migraines in only one of the two age groups.

The HLS provides the opportunity to compare self reported measures of morbidity with physiological indicators of health status in the form of blood pressure, pulse rate and respiratory functioning and with cognitive functioning, as measured by reaction time. After controlling for whether or not the individual reported long standing illness, as well as their age and sex, chi-square tests were used to determine if there was a significant relationship between an individual's income category and whether or not their blood pressure and pulse rate fell within a normal range[10]. Generally, a higher proportion of individuals from the lower income groups had abnormal blood pressure; this relationship was significant ($p=0.05$) in two of the six age/sex groups among individuals reporting no long standing illness. No significant differences were identified for pulse rate[11].

Two way analysis of variance in respiratory functioning, controlling for self reported morbidity and income group, revealed a significant difference ($p << 0.001$) in favour of the higher income groups in this measure of health status[12]. Four way analysis of variance in reaction time, controlling for the same two variables plus age and sex, showed a significant difference ($p << 0.001$) in favour of the higher income groups in cognitive functioning.

The evidence is not overwhelming but it is sufficient to cast doubt on the assumption that among individuals categorised by self reported morbidity, health status is, on average, equal across income groups. For a given level of self reported morbidity, individuals in the lower income groups are more likely to suffer multiple and more serious conditions and their health status, as measured by blood pressure and respiratory and cognitive functioning, is likely to be lower. Thus we can perhaps conclude that the weakly pro-poor distribution of NHS care standardising for self reported morbidity, identified above, may actually reflect allocation according to need, rather than unequal treatment for equal health status.

3 THE PROGRESSIVITY OF HEALTH CARE FINANCE IN BRITAIN

Public expenditure accounts for 95.2% of total expenditure on health care in Britain; 97% of the finance of public health care is raised through general taxation (OHE, 1987). Consequently, the progressivity of the financing of health care in the UK is largely determined by the progressivity of the tax system[13]. Central Statistical Office (CSO) publish tables annually showing the distribution of the tax burden across the population ranked by income (CSO, 1986). These tables are generated from data collected in the annual Family Expenditure Survey (FES) for 1985. The figures reported in this paper are taken from the published CSO tables.

Households are ranked according to their gross household income and decile groups formed. On the basis of certain incidence assumptions, tax payments are allocated to each group. The results are presented in Table 3. Both the Kakwani and Suits indices show that income taxation is progressive.[15] This results from the existence of income tax allowances and a variety of tax

rates which rise with income and the fact that certain groups, such as the elderly, are exempt from income tax. The indices are again positive for National Insurance contributions but the lower absolute values indicate that this is closer to a proportional tax. National Insurance contributions are paid by both employees and employers. The CSO estimates are based upon the assumption that the incidence of the employers' contributions are borne by consumers. An alternative incidence assumption (used in most of the other studies reported in this volume) is that employers shift the incidence of NI contributions onto employees, in the form of lower gross wages. O'Higgins and Ruggles (1981) using 1971 FES data compared the progressivity of employers' NI contributions under both incidence assumptions. They found that the assumption used by CSO (forward shifting onto consumers) results in employers' NI contributions being regressive whereas the alternative assumption results in proportionality. Hence, if the alternative assumption had been employed, the distribution of NI contributions would have been more progressive than is indicated in Table 3.

The distribution of indirect tax revenues in relation to incomes results in a negative value for both the Kakwani and Suits indices, indicating that these taxes are regressive. Overall, the Kakwani and Suits indices reflecting the relationship between the distribution of total tax payments and incomes, are positive, indicating a progressive tax system. However, both indices are close to zero (0.068) and so the overall departure from proportionality is slight.

The data presented in Table 3 only give a partial picture of the progressivity of the UK tax system. The CSO allocated only 59.8% of all Government revenues to income groups. Whether the whole tax system is

progressive or regressive is dependent upon the distribution of the burden of the remaining unallocated taxes. These unallocated taxes consist of commercial and industrial rates, part of VAT, corporation tax, capital tax, petroleum revenue tax, licenses on various goods and services and two-thirds of employers' NI contributions. O'Higgins and Ruggles (1981) using 1971 FES data and various incidence assumptions succeeded in allocating these taxes. They found, on the basis of the allocation of 100% of tax revenues, the tax system was broadly proportional, whereas the CSO estimates showed a progressive system. The results from this study suggest that the whole tax system is less progressive than is indicated by the figures in Table 3. On the other hand, Dilnot et al (1990) suggest that the CSO figures underestimate the progressivity of the UK tax system. They question the validity of the CSO assumption that taxes on intermediate goods and services are shifted forwards onto commodity prices. Using an alternative assumption that these taxes are incident on factor incomes, they find the tax system is more progressive than is indicated by the CSO estimates.

A small proportion, 3%, of NHS expenditure is financed from direct patient charges.[16] Examination of the data from the GHS has revealed that the lower income groups make greater use of NHS services (see section 2.2). Ceteris paribus, this would mean direct charges are a regressive means of finance. However, many individuals in the lower income groups are exempt from charges. Smith and Watson (1990), using FES data found that an income below the level at which there is exemption from charges reduces the utilisation of prescriptions on which a charge is made. In addition, the level of household consumption (a proxy for income) was found to be negatively associated with the utilisation of prescriptions on which a charge is made. These results suggest that payments of direct charges are low at very low

levels of income, rise rapidly for moderately low incomes and then fall as incomes rise. However, in the absence of more specific data it is not possible to say whether user charges are progressive or regressive in Britain.

Table 3 DISTRIBUTION OF TAX PAYMENTS, GB 1985

Income Decile (a)	(1) % of Gross Income	(2) % of Income Tax Revenues (b)	(3) % of National Insurance Revenues (c)	(4) % of Indirect Tax Revenues (d)	(5) % of Total Tax Revenues	(6) % of Post Tax Income
Bottom	2.23	0.03	0.83	2.60	1.19	2.72
2nd	3.20	0.35	1.13	3.74	1.83	3.85
3rd	4.29	0.84	2.02	5.45	2.88	4.94
4th	5.85	3.00	4.58	7.25	4.97	6.23
5th	7.58	5.60	7.76	8.69	7.22	7.72
6th	9.32	7.72	10.42	10.28	9.23	9.32
7th	11.19	10.72	12.91	11.29	11.35	11.10
8th	13.46	14.01	15.97	13.87	14.32	13.03
9th	16.67	19.76	19.12	15.51	17.96	16.08
Top	26.21	37.98	25.25	21.32	29.03	25.01
% of total revenue	(e)	41.88	18.61	39.51		
Gini (non-linear)	0.380	0.575	0.449	0.311	0.448	0.349
Kakwani index		0.195	0.069	-0.069	0.068	
Suits index	(f)	0.213	0.051	-0.079	0.068	

Sources: Columns 1-4 and 6: CSO May 1986 Table 6
Column 5: average of columns 2-4 weighted by % of revenue

Notes:
a Decile groups of households ranked by gross household income
b Net of tax relief at source
c Approximately 1/3 of employers' NI contributions are fully forward shifted onto consumers. The rest are unallocated. All employees NI contributions allocated.
d Excluding rates
e These figures are the percentages of total allocated tax revenues and were calculated from CSO (1986) Table 2.
f Based on relative concentration curves, which were estimated using linear extrapolation

To determine the progressivity of the finance of the whole health care system in Britain, the distribution of payments for private care must be considered in addition to the distribution of tax contributions. Unfortunately, there is no data available on the distribution of private health care payments across income groups.[17] However, the majority of private health care in Britain is financed by private insurance. Data from the 1987 GHS gives a picture of private health insurance coverage (though not payments) by equivalised income group. Table 4 shows the percentage of all those covered by private health insurance in each income group. The top two quintiles account for almost 84% of those covered by private health insurance. Assuming that the incidence of employer provided health insurance is shifted onto the salaries of employees, the figures presented in Table 4 indicate that private health insurance payments are strongly correlated with income. Under this assumption, if payments for private health insurance were added to tax payments the finance of health care in Britain would appear more progressive than is indicated by the data presented in Table 3. An alternative assumption is that the incidence of employer provided insurance is shifted onto consumers. In this case, the progressivity of private health insurance in the UK is more ambiguous.

Table 4 DISTRIBUTION OF PRIVATE HEALTH INSURANCE COVERAGE

Equivalent Income Quintile	% of private health insurance
Bottom	1.6%
2	4.0
3	10.6
4	22.4
Top	61.4
	100.0

Source: 1987 GHS

4 CONCLUSIONS

In this paper we make a distinction between equity in the delivery and in the finance of health care, as the equity goals advanced for the two sides of the health care market differ. On the delivery side, the often stated policy goal was and appears to remain 'equal treatment for equal need'. On the finance side, the tax financed nature of NHS means that the equity goals for the finance side are those that apply to the whole tax system - goals of progressivity or at least proportionality.

On the delivery side, it is well established that the distribution of health in Britain is unequal. Individuals in lower income groups report and have lower health status than those in higher income groups. The data used in the present study - self-reported morbidity measures from the General Household Survey (GHS) - confirm this pattern. However, the distribution of resources is also unequal - the GHS data indicating that individuals in lower income groups receive more NHS resources than those in higher income quintiles. A simple comparision of the distribution of resources with the distribution of reported morbidity indicates a slight overall pro-rich distribution. However, this methodology is not appropriate for assessing whether the allocation of resources is consistent with the objective, 'equal treatment for equal need'. After appropriate standardisation for differences in the distribution across income groups in age, gender and the incidence of types of reported morbidity, there is little evidence of substantial inequity in the distribution of health care in Britain. The distribution of standardised NHS expenditure has a slightly pro-poor bias, whilst total standardised expenditure (adults only) displays a slightly pro-rich bias.

There are some systematic variations in the results. Total health care resources (i.e. private and NHS care) are distributed more in favour of the higher income groups than NHS resources, a result wholly consistent with the nature of the UK private health care system. This finding holds for both the adult-only sub-sample and for the adult and children sample. The results are sensitive to the self-reported morbidity measures used to define 'need'; the addition of more measures and more finely defined measures reduces an apparently pro-poor bias in the standardised distribution. Again, the same result arises whether we examine only adults or both adults and children.

The pro-poor bias in the standardised distribution of NHS resources is small. But there is evidence to suggest that this small departure from proportionality may be an overstatement of the extent of pro-poor bias in the distribution of health care resources. The methodology used relies upon the assumption that there is no systematic difference in the health of individuals within any given morbidity category. In particular it is assumed that the average health within each category does not differ with income. Our analysis of data from the Health and Lifestyles Survey suggests this may be an incorrect assumption: within each morbidity group the poorer in fact appear to be sicker. Thus we conclude that on these grounds the GHS data overstates the degree of any pro-poor bias in the distribution of health care resources. On the other hand, we have only crude measures of resources spent. In particular, the GHS does not permit measurement of the quality of care received. If those in higher income groups get better quality care, then the distribution derived in this paper will underestimate the extent of pro-rich bias.

The evidence on the finance side shows that the UK tax system, from which the vast majority of health care is financed, is close to being proportional to income. But there remain some sources of finance which we were unable to allocate. The CSO estimates of the distribution of the tax burden which are used in this paper are incomplete and there is evidence from O'Higgins and Ruggles, (1981) that those taxes which are unallocated by the CSO are more regressive than those allocated. Our estimates do not incorporate the distribution of user charges for the NHS nor payments for private health care. A priori, it is not possible to determine whether user charges are progressive or regressive. However, they only account for 3% of NHS finance. From evidence on the distribution of private health insurance coverage, payments for private care appear progressive[18], because it is predominantly the higher income groups who purchase private care to supplement or substitute for NHS care in Britain. These omissions work in opposite directions; as unallocated taxes are rather larger than private finance or user charges we suggest that the finance side is more regressive than the CSO data indicates.

Overall, however, our conclusions are that the predominantly publicly financed and publicly provided health care system in Britain appears close to allocating health care resources on the basis of 'equal treatment for equal need' and extracting payments in proportion to incomes. This conclusion must be qualified with a reminder that the data available for analysis are incomplete and often crude and we are analysing data for one year only, but these are the best data currently available for the UK.

NOTES

1 A family is defined in GHS as either: (i) a married couple on their own, or (ii) a married couple/lone parent and their unmarried children, provided these children have no children of their own.

2 Equivalent income is calculated by adjusting income by an equivalence scale. The equivalence scale used is that derived by McClements (1978) from data on expenditure patterns taken from the 1971 and 1972 Family Expenditure Surveys. It is the following:

	WEIGHT
Married couple	1.64
Single adult householder	1.00
2nd adult non-household	0.75
3rd adult non-household	0.69
4th adult non-household	0.59
Child 0-1 years	0.15
Child 2-4 years	0.30
Child 5-7 years	0.34
Child 8-10 years	0.38
Child 11-12 years	0.41
Child 13-15 years	0.44
Child 16-18 years	0.59

3 In previous years the GHS has contained information on length of stay. Le Grand (1978) exploited this multiplying the number of inpatient days by the average cost per day, to get the total cost of inpatient care

consumed by each individual. This procedure is also likely to result in an inaccurate description of the distribution of health care. The marginal cost of an additional inpatient day is likely to be much less than the average cost and so the resource cost of longer than average lengths of stay will be overestimated using this methodology.

4 The cost figures used for GP visits were estimated by the DHSS (Tinker, 1984) and have been inflated to 1985/86 price levels using the Hospital and Community Health Services pay and prices deflator. The Health Service Costing Returns, 1985/86 (DHSS and Welsh Office, 1987) were used to calculate the average cost of an outpatient or accident and emergency department visit and the average cost of an in-patient stay in a non-long stay hospital in England and Wales.

5 In the figures presented, the same unit cost for a GP visit is used whether or not a prescription was issued. We have experimented with using a higher cost for consultations resulting in a prescription. This made very little difference to the results.

6 The analysis was also carried out by decile group. The results were not statistically different and in many cases identical to the third decimal place.

7 A possible method of calculating standard errors for the indices has been proposed by Elleman-Jensen (1989).

8 The concentration indices were calculated by the non-linear approximation method. For the whole sample they were also calculated

by the method suggested by Jenkins (1988). The two methods gave very similar results.

9 For details of the test procedure the reader is referred to the Appendix. Tables A3(a) and A3(b) give the (independent) probit and OLS results for the full sample, Tables A4(a) and A4(b) give the corresponding adult only results. These tests were undertaken only for the fullest set of standardising variables. Where concentration curves crossed the 45° line, the Jenkins method was used.

10 The normal range for mean arterial blood pressure (70-109 mm Hg) and for pulse rate (70-109 bpm) are both taken from APACHE II (Kraus et al, 1985). Using the latter, 48% of the sample had a pulse rate outside the normal range. The normal range was therefore extended to 55-109 bpm.

11 This was true using either normal range for pulse rate.

12 The indicator of respiratory functioning used was actual forced expiratory volume divided by predicted forced expiratory volume. The latter is generated from a regression which has age, sex and stature as independent variables and so there was no need to further standardise for differences in the age/sex compositions of the income groups.

13 In this paper we are concerned with the finance of health care. In theory, those who bear the cost of a publicly funded service, such as the British NHS, are those who would benefit if it were to cease to exist and the resources released were put to some alternative use.

Empirical study of the distribution of the costs of such a service requires identification of the most likely alternative use of the resources. Three (non-mutually exclusive) alternatives are possible. The government may increase spending on another public service. Taxes may be reduced and/or the Government budget surplus (deficit) may be increased (reduced) (Le Grand, 1985). Each combination of these alternatives will have a different implication for the distribution of benefits from the removal of the service, and so, the distribution of the costs it imposes. The problem is to identify the most plausible counterfactual hypothesis. We make no attempt to identify the distribution of the economic cost of the NHS. The less ambitious objective is to describe the distribution of the total tax bill, from which the NHS is financed.

15 Positive and negative indices represent progressive and regressive taxes respectively. Indices were calculated using the non-linear approximation method.

16 Charges are made for pharmaceutical prescriptions issued by GPs, dental and ophthalmic.

17 The FES does provide data on payments for private health insurance made by individuals. However, individual purchase of private health insurance accounts for only 40% of all purchases. Analysis of GHS data revealed that among the population covered by private health insurance the proportion of purchases made by employers increased with income group. Assuming the incidence of employer provided health insurance is shifted onto salaries, analysis of the FES data would give a biased

indication of the distribution of payments for private health insurance.

18. Assuming the incidence of employers' payments for private insurance are borne by employees.

APPENDIX

Tests of Model Specification

A probit and OLS specification was adopted for the standardisation procedure. This procedure implicitly assumes that the first equation is independent of the second. If this assumption is incorrect, the parameter estimates derived under the hypothesis of independence will be biased and the standardised results biased. Possible alternative hypotheses are a tobit model or a sample selection model. The tobit model embodies the hypothesis that the effect of the standardisation variables on the probit equation are the same as in censored OLS. The sample selection model hypothesises that the error term of the probit equation is not independent of the error term of the censored OLS.

The test statistic for the test of a tobit specification is:

$$RV = 2(\ln tobit-(\ln trunc+\ln probit))$$

where Lntobit is the value of the tobit log-likelihood Intrunc is the log-likelihood for the truncated OLS etc. The test statistic is distributed X^2 with degrees of freedom equal to difference in number of regressors between the tobit and the truncated OLS+probit (Godfrey 1988). To undertake the second test the independent probit and OLS were tested against a Heckman two part model.

The results are presented in Tables A1 and A2. The tobit specification was rejected in all cases for both samples; the sample selection model could be rejected for all but quintiles 1 and 4 in the adult sample. In these two cases the estimate of the effect of the omitted correlation in the second equation was not significant and so the two part probit and OLS specification was adopted.

Tests of Significance of Income Effects

Log-likelihood ratio (LR) tests were made first for any income differences. For each quintile independent probit and censored OLS equations were estimated and the log-likelihood derived for each quintile (see Tables A1 and A2). The same model was estimated for the whole sample. The test statistic is

$$RV = 2(\Sigma_j \ln L_j - \ln L), \text{ distributed } X^2_r,$$

where $\ln L_j$ = log-likelihood for quintile j, LnL = log-likelihood for the whole sample and r = difference between the number of parameters in the unrestricted and restricted equations.

To test interaction terms in income separately from autonomous terms in income the probit and OLS models were estimated using all quintiles but allowing interactions between 4 of the income groups and the age, sex and morbidity dummies plus 4 income group dummies (the autonomous terms). The restrictions that the autonomous terms = 0 and the interaction terms = 0 can be tested separately. The relevant log-likelihood statistics are presented in Tables A3 and A4.

Table A1:

Whole sample (N=17729)

	Income Quintile 1	2	3	4	5
Tobit lnL	-10875.0	-9971.6	-9030.7	-8915.5	-8546.6
Trunc OLS lnL	-8643.2	-7820.0	-6995.6	-6853.5	-6530.4
Probit lnL	-2121.5	-2064.5	-1986.7	-1995.6	-1949.0
Heckman lnL	-9270.7	-8385.9	-7435.2	-7347.6	-7014.3
OLS lnL	-9270.9	-8385.9	-7435.16	-7347.9	-7014.6
OLS R^2	0.019	0.038	0.037	0.031	0.033
Tests on probit					
Chi^2(14 df)	24.7	61.2	65.7	61.3	21.9
Normality(2 df)	1.97	2.52	13.86	1.77	4.44
Skewness(1 df)	0.40	2.31	2.02	1.72	3.10
Kurtosis(1 df)	0.02	1.16	0.33	1.49	2.06
n	3545	3548	3546	3547	3543

Table A2:
Adults Only (N=13204)

	Income Quintile 1	2	3	4	5
Tobit lnL	-8330.3	-7785.9	-6834.0	-6475.2	-6326.4
Trunc OLS lnL	-6735.0	-6187.7	-5359.8	-5014.1	-4855.0
Probit ln L	-1539.4	-1522.2	-1441.7	-1415.7	-1421.8
Heckman lnL	-7163.3	-6632.0	-5669.3	-5364.6	-5207.9
OLS lnL	-7166.0	-6632.1	-5669.7	-5368.6	-5207.9
OLS R^2	0.047	0.082	0.049	0.095	0.144
Tests on Probit					
Chi^2(14 df)	41.65	44.59	38.89	40.72	21.106
Normality(2 df)	4.01	1.18	1.59	2.59	1.36
Skewness(1 df)	1.83	0.46	0.55	1.44	0.67
Kurtosis(1 df)	0.03	0.01	0.00	0.02	0.00
n	2642	2640	2639	2642	2641

Notes for tables A1 and A2:

1 lnL = log likelihood

2 Test for Probit and OLS versus Probit and Heckman 2 stage estimates = 2(Ln OLS - Ln Heckman)~chi^2(1)

3 Chi^2 test is Orme (1988); degrees of freedom in parentheses

4 Normality, skewness and kurtosis tests from Bera & Jarque (1984); degrees of freedom in parentheses

Table A3(a) PROBIT ESTIMATES FOR POSITIVE EXPENDITURE, ALL INCOME GROUPS TOGETHER

Adults and children

Variable	Coefficient	Std. Error	T-ratio	Mean of X
ONE	-0.758246	0.511591E-01	-14.821	1.0000
AGE34	0.144589	0.678801E-01	2.130	0.24891
AGE44	-0.133464	0.961051E-01	-1.389	0.13424
AGE64	-0.377840	0.764980E-01	-4.939	0.20740
AGEOLD	-0.234318	0.650303E-01	-3.603	0.15506
FEMALE	0.210851	0.465196E-01	4.533	0.52079
LTDCHRON	0.891791	0.561076E-01	15.894	0.17593
CHRONIC	0.488793	0.692609E-01	7.057	0.13086
EQINC2	-0.731772E-01	0.725868E-01	-1.008	0.20012
EQINC3	-0.244335E-01	0.697797E-01	-0.350	0.20001
EQINC4	-0.187515E-01	0.715740E-01	-0.262	0.20007
EQINC5	-0.403546E-01	0.796318E-01	-0.507	0.19984
CHRONQ2	-0.113218	0.965570E-01	-1.173	0.27243E-01
CHRONQ3	0.936119E-01	0.962613E-01	0.972	0.25890E-01
CHRONQ4	0.323738E-02	0.975423E-01	0.033	0.23634E-01
CHRONQ5	-0.494504E-01	0.946485E-01	-0.522	0.28654E-01
LCHRONQ2	-0.426545E-01	0.810436E-01	-0.526	0.47324E-01
LCHRONQ3	-0.247171E-01	0.862801E-01	-0.286	0.28541E-01
LCHRONQ4	-0.109175	0.903654E-01	-1.208	0.22844E-01
LCHRONQ5	-0.788142E-01	0.917948E-01	-0.859	0.21377E-01
AGE34Q2	0.134466E-01	0.964900E-01	0.139	0.37227E-01
AGE34Q3	-0.991670E-01	0.911933E-01	-1.087	0.49636E-01
AGE34Q4	-0.103825	0.913426E-01	-1.137	0.57476E-01
AGE34Q5	-0.163360	0.966079E-01	-1.691	0.67742E-01
AGE44Q2	0.142335	0.129100	1.103	0.19516E-01
AGE44Q3	-0.528378E-01	0.120481	-0.439	0.31079E-01
AGE44Q4	-0.214978E-01	0.120400	-0.179	0.33956E-01
AGE44Q5	0.434082E-01	0.124500	0.349	0.35197E-01
AGE64Q2	0.253687	0.105954	2.394	0.36268E-01
AGE64Q3	0.112655	0.103498	1.088	0.38242E-01
AGE64Q4	0.209196	0.102092	2.049	0.45124E-01
AGE64Q5	0.141784	0.105976	1.338	0.54769E-01
AGEOLDQ2	0.162226	0.933593E-01	1.738	0.53923E-01
AGEOLDQ3	-0.100900E-02	0.110164	-0.009	0.17993E-01
AGEOLDQ4	0.230516E-01	0.130575	0.177	0.10096E-01
AGEOLDQ5	0.310784E-01	0.138881	0.224	0.90248E-02
FEMALEQ2	-0.102648	0.651982E-01	-1.574	0.10920
FEMALEQ3	-0.958065E-01	0.654463E-01	-1.464	0.10164
FEMALEQ4	-0.743247E-01	0.653580E-01	-1.137	0.97580E-01
FEMALEQ5	-0.399296E-01	0.656219E-01	-0.608	0.93068E-01

N = 17729
Unrestricted Log-Likelihood.....-10117
Restricted (no income cross products) Log-Likelihood.....-10131
Restricted (no income only terms) Log-Likelihood.....-10118
Restricted (no income terms) Log-Likelihood.....-10136

Table A3(b) OLS ESTIMATES ON POSITIVE EXPENDITURE ACROSS ALL INCOME GROUPS TOGETHER

Adults and Children

Variable	Coefficient	Std. Error	T-ratio	Mean of X
ONE	432.997	36.0148	12.023	1.0000
AGE34	127.221	44.7597	2.842	0.26137
AGE44	-82.3151	64.3867	-1.278	0.12130
AGE64	-32.8474	52.1564	-0.630	0.19733
AGEOLD	-36.5628	43.6647	-0.837	0.18282
FEMALE	-12.2078	30.9348	-0.395	0.56626
LTDCHRON	120.025	36.1235	3.323	0.30335
CHRONIC	18.9662	45.0718	0.421	0.16541
EQINC2	-27.8129	52.3972	-0.531	0.21029
EQINC3	-80.0718	49.2782	-1.625	0.19133
EQINC4	-71.9603	50.9656	-1.412	0.18708
EQINC5	-105.479	56.6738	-1.861	0.17837
CHRONQ2	-13.1163	64.5282	-0.203	0.31534E-01
CHRONQ3	2.53856	62.6377	0.041	0.35403E-01
CHRONQ4	5.22586	64.1261	0.081	0.30954E-01
CHRONQ5	-48.8578	63.0536	-0.775	0.33856E-01
LCHRONQ2	68.2110	52.2181	1.306	0.82221E-01
LCHRONQ3	72.9295	55.0235	1.325	0.48365E-01
LCHRONQ4	74.7291	56.5615	1.321	0.37918E-01
LCHRONQ5	60.5952	57.0610	1.062	0.35210E-01
AGE34Q2	41.4145	65.9474	0.628	0.40627E-01
AGE34Q3	-25.0339	61.9829	-0.404	0.52234E-01
AGE34Q4	-14.9428	62.6774	-0.238	0.57845E-01
AGE34Q5	-20.4452	66.6355	-0.307	0.67742E-01
AGE44Q2	76.2521	88.6081	0.861	0.19346E-01
AGE44Q3	106.124	83.2115	1.275	0.25924E-01
AGE44Q4	127.679	83.2823	1.533	0.28052E-01
AGE44Q5	170.495	85.7652	1.988	0.31921E-01
AGE64Q2	9.94833	73.2638	0.136	0.39466E-01
AGE64Q3	27.8739	72.0795	0.387	0.35403E-01
AGE64Q4	36.9288	70.9845	0.520	0.42175E-01
AGE64Q5	53.9577	74.2913	0.726	0.44883E-01
AGEOLDQ2	81.6426	63.5574	1.285	0.65003E-01
AGEOLDQ3	-5.84469	75.2139	-0.07	0.18379E-01
AGEOLDQ4	-44.6883	89.7358	-0.498	0.10060E-01
AGEOLDQ5	38.8032	95.4579	0.406	0.90927E-02
FEMALEQ2	-30.5179	44.1647	-0.691	0.11975
FEMALEQ3	29.6268	45.1486	0.656	0.10350
FEMALEQ4	16.5571	45.4193	0.365	0.99632E-01
FEMALEQ5	64.7031	45.5646	1.420	0.92087E-01

N = 5169
Unrestricted Log-Likelihood.....-39481.5
Restricted (no income cross-products) Log-Likelihood.....-39494.2
Restricted (no income only terms) Log-Likelihood.....-39484.0
Restricted (no income terms) Log-Likelihood.....-39496.0

Table A4(a) PROBIT ESTIMATE ALL INCOME GROUPS TOGETHER

Adults only

Variable	Coefficient	Std. Error	T-ratio	Mean of X
ONE	-0.624003	0.635672E-01	-9.816	1.0000
AGE44	-0.314260	0.999640E-01	-3.144	0.1802
AGE64	-0.591484	0.811561E-01	-7.288	0.27817
AGEOLD	-0.419250	0.691541E-01	-6.063	0.20751
FEMALE	0.209538	0.552210E-01	3.795	0.53416
LTDCHRON	0.576852	0.681472E-01	8.465	0.21350
CHRONIC	0.392443	0.805880E-01	4.870	0.14571
HEALTH	0.703677	0.690134E-01	10.196	0.12564
EQINC2	-0.840018E-01	0.886980E-01	-0.947	0.19994
EQINC3	-0.175156	0.841969E-01	-2.080	0.19986
EQINC4	-0.180903	0.826677E-01	-2.188	0.20009
EQINC5	-0.224606	0.817741E-01	-2.747	0.20002
CHRONQ2	-0.153026	0.111928	-1.367	0.29612E-01
CHRONQ3	0.842645E-01	0.109834	0.767	0.30142E-01
CHRONQ4	0.194228E-01	0.111505	0.174	0.27037E-01
CHRONQ5	-0.469121E-01	0.109011	-0.430	0.30975E-01
LCHRONQ2	-0.189367E-01	0.984200E-01	-0.192	0.59073E-01
LCHRONQ3	-0.566736E-01	0.105351	-0.538	0.35065E-01
LCHRONQ4	-0.107651	0.109871	-0.980	0.26356E-01
LCHRONQ5	-0.281573E-01	0.111217	-0.253	0.22796E-01
HEALTHQ2	-0.212187E-01	0.101971	-0.208	0.36731E-01
HEALTHQ3	0.152117	0.120228	1.265	0.19388E-01
HEALTHQ4	0.356058	0.130896	2.720	0.13859E-01
HEALTHQ5	0.314563	0.148713	2.115	0.91639E-02
AGE44Q2	0.165385	0.133929	1.235	0.27037E-01
AGE44Q3	0.758318E-01	0.123711	0.613	0.44456E-01
AGE44Q4	0.141908	0.122873	1.155	0.46047E-01
AGE44Q5	0.243574	0.123152	1.978	0.43093E-01
AGE64Q2	0.279644	0.112309	2.490	0.49758E-01
AGE64Q3	0.251543	0.106611	2.359	0.57407E-01
AGE64Q4	0.322220	0.105258	3.061	0.61951E-01
AGE64Q5	0.415165	0.104008	3.992	0.64602E-01
AGEOLDQ2	0.189564	0.997323E-01	1.901	0.72099E-01
AGEOLDQ3	0.541878E-01	0.113546	0.477	0.25674E-01
AGEOLDQ4	0.166425	0.135528	1.228	0.12799E-01
AGEOLDQ5	0.233285	0.143612	1.624	0.10603E-01
FEMALEQ2	-0.732502E-01	0.768196E-01	-0.954	0.11337
FEMALEQ3	0.712398E-01	0.773297E-01	0.921	0.10330
FEMALEQ4	-0.769877E-02	0.774331E-01	-0.099	0.97773E-01
FEMALEQ5	0.704081E-02	0.773122E-01	0.091	0.92775E-01

N = 13204
Unrestricted Log-Likelihood.....-7340.8
Restricted (no income cross-products) Log-Likelihood.....-7363.9
Restricted (no income only terms) Log-Likelihood.....-7345.5
Restricted (no income terms) Log-Likelihood.....-7364.0

Table A4(b) OLS ESTIMATES ON POSITIVE EXPENDITURE, (EXP|EXP>0)
ALL INCOME GROUPS TOGETHER

Adults only

Variable	Coefficient	Std. Error	T-ratio	Mean of X
ONE	540.341	43.6653	12.375	1.0000
AGE44	-211.622	64.3138	-3.290	0.15922
AGE64	-166.515	52.5646	-3.168	0.25876
AGEOLD	-148.923	43.4615	-3.427	0.23921
FEMALE	9.58868	35.6195	0.269	0.60056
LTDCHRON	-23.8683	43.4990	-0.549	0.35627
CHRONIC	-77.8925	52.6255	-1.480	0.16963
HEALTH	212.296	37.8955	5.602	0.26816
EQINC2	32.1322	63.0507	0.510	0.21762
EQINC3	-92.0513	59.8870	-1.537	0.19147
EQINC4	-96.7428	59.3710	-1.629	0.17902
EQINC5	-139.497	58.5037	-2.384	0.17471
CHRONQ2	42.4573	75.4700	0.563	0.30980E-01
CHRONQ3	61.3326	72.2831	0.849	0.37583E-01
CHRONQ4	41.2416	74.3020	0.555	0.31742E-01
CHRONQ5	38.9140	72.9098	0.534	0.34281E-01
LCHRONQ2	53.7312	63.5545	0.845	0.10107
LCHRONQ3	60.9981	67.4788	0.904	0.56628E-01
LCHRONQ4	75.8734	68.9571	1.100	0.41646E-01
LCHRONQ5	6.68122	69.1231	0.097	0.36059E-01
HEALTHQ2	101.353	57.3320	1.768	0.75419E-01
HEALTHQ3	-2.40799	64.5925	-0.037	0.42153E-01
HEALTHQ4	168.202	67.0602	2.508	0.32504E-01
HEALTHQ5	350.219	72.9120	4.803	0.22092E-01
AGE44Q2	28.0113	88.4072	0.317	0.26409E-01
AGE44Q3	143.328	82.3368	1.741	0.36567E-01
AGE44Q4	124.171	82.4049	1.507	0.37329E-01
AGE44Q5	219.531	82.2947	2.668	0.37583E-01
AGE64Q2	-47.2877	74.3532	-0.636	0.52311E-01
AGE64Q3	52.9621	71.3476	0.742	0.53073E-01
AGE64Q4	58.9880	71.1622	0.829	0.53327E-01
AGE64Q5	69.0468	70.2319	0.983	0.53580E-01
AGEOLDQ2	-4.15952	64.5760	-0.064	0.85322E-01
AGEOLDQ3	-1.13903	75.0962	-0.015	0.25140E-01
AGEOLDQ4	-0.484562	90.4273	-0.005	0.12697E-01
AGEOLDQ5	-47.4432	95.4268	-0.497	0.10665E-01
FEMALEQ2	-63.5549	50.4473	-1.260	0.12925
FEMALEQ3	27.1762	52.1178	0.521	0.11529
FEMALEQ4	14.4203	52.6641	0.274	0.99543E-01
FEMALEQ5	51.3356	52.5808	0.976	0.93956E-01

N = 3938
Unrestricted Log-Likelihood.....-30068.0
Restricted (no income cross-products) Log-Likelihood.....-30096.0
Restricted (no income only terms) Log-Likelihood.....-30073.8
Restricted (no income terms) Log-Likelihood.....-30100.4

REFERENCES

Bera, A.K., Jarque, C.M. and Lee, L.S. (1984), 'Testing normality assumptions in limited dependent variable models' International Review of Economics, 25, 563-78.

Blaxter, M. (1990) 'A comparision of measures of inequality in morbidity' in Fox, J. (ed) Health Inequalities in European Countries, Gower, London.

Buchan, I.C. and Richardson, I.M. (1973) Time study of consultations in General Practice, Scottish Health Studies, no. 27, Scottish Home and Health Department.

Cartwright, A., Lucas, S. and O'Brien, M. (1974) 'Exploring communication in General Practice', report to the Social Science Research Council.

Cmd 555 (1989) Working for Patients, HMSO, London.

Collins, E. and Klein, K. (1980) 'Equity and the NHS: self reported morbidity, access and primary care', British Medical Journal, vol. 281, 1111-1115.

Cox, B. D., Blaxter, M., Buckle, A. L. T. et al (1987) The Health and Lifestyle Survey, Health Promotion Research Trust, London.

CSO (1986) 'The effects of taxes and benefits on household income, 1985' Economic Trends, November, 1986, HMSO, London.

Culyer, A.J., Maynard, A. and Posnett, J. (1990) Competition in Health Care: Reforming the NHS, Macmillan, London.

DHSS and Welsh Office (1987) Health Service Costing Returns 1985/86, HMSO, London.

Dilnot, A., Kay, J. and Keen, M. (1990) 'Allocating Taxes to Households: a methodology', Oxford Economic Papers, 42: 210-30.

Elleman-Jensen, P. (1989) 'Bootstrapping concentration indices' COMAC project on Distribution Aspects of Health Care, Research Note No. 1.

Godfrey, L. (1988) Mis-specification Tests in Econometrics, CUP, Cambridge.

Hurst, J. W. (1985) Financing Health Services in the United States, Canada and Britain, Kings Fund, London.

Jenkins, S (1988) 'Calculating income distribution indices from microdata' National Tax Journal, 61, 139-142

Kakwani N. C. (1977) 'Measurement of tax progressivity: an international comparison' Economic Journal, 87, 71-80.

Kraus, W. P., Draper, E. A., Wagner, D. P. and Zimmerman, J. E. (1985) APACHE II: A severity of disease classification system', Critical Care Medicine, 13, 818-829.

Laing, (1987) Laing's Review of Private Health Care 1987, Laing and Buisson, London.

Le Grand, J. (1978) 'The distribution of public expenditure: the case of health care', Economica, 45, 125-42.

Le Grand, J. (1985) 'On measuring the distributional impact of public expenditure'. A.J. Culyer and G Terny (eds), Public Finance and Social Policy, Wayne State Press, Detroit.

McClements, L. D. (1978) The Economics of Social Security, Heinemann, London.

Metcalfe, D., Wilkin, D. et al (1983) 'A study of process of care in urban General Practice'. A report prepared for the DHSS.

Nicholl, J.P., Beeby, N.R. and Williams, B.T. (1989) 'Role of the private sector in elective surgery in England and Wales, 1986', British Medical Journal, vol. 298, 243-47

O'Donnell, O. and Propper, C. (1991) 'Equity and the Distribution of UK National Health Service Resources' Journal of Health Economics, forthcoming.

OHE (1987) OHE Compendium of Health Statistics, 6th Edition, 1987, OHE, London.

O'Higgins, M. and Ruggles, P. (1981) 'The distribution of public expenditures and taxes among households in the United Kingdom' Review of Income and Wealth, 27 (2), 298-326.

Orme, C. (1988) 'The Calculation of the Information Matrix Test for Binary Data Models' The Manchester School, CVI (4), 370-376.

Propper, C. and Maynard, A. (1990) 'Whither the Private Health Care Sector?' in A. Culyer, A. Maynard and J. Posnett (eds) Competition in Health Care: Reforming the NHS, Macmillan, London.

Smith, S. and Watson, S. (1990) 'Modelling the effect of prescription charges' Fiscal Studies, 11 (1): 75-95.

Suits, D (1977) 'Measurement of tax progressivity' American Economic Review, 67, 747-752

Tinker, A. (1984) Staying at Home, Department of Environment, HMSO, London.

Wagstaff, A., van Doorslaer, E. and Paci, P. (1990) 'Progressivity and horizontal equity in the finance and delivery of health care: some tentative cross-country comparisons' Paper presented at the Second World Congress on Health Economics, Zurich 10-14 September 1990.

Wagstaff, A., van Doorslaer, E. and Paci, P. (1991) 'On the measurement of horizontal equity in the delivery of health care' Journal of Health Economics, forthcoming.